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THE
METRIC SYSTEM

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THE METRIC SYSTEM

AND

INTERCHANGE OF WEIGHTS AND MEASURES

Louis L. BY *John F. Gribbens*

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THE METRIC SYSTEM.

The Metric System of Weights and Measures originated in France near the close of the last century and its use was enforced there by law in 1840. Since that time its decisive advantages over existing systems have so brought it into favor among other nations, that to-day its use is permitted or made obligatory in nearly the whole of the civilized world.

In the United States the use of the Metric System was made legal, by act of Congress, in 1866. It is employed by the government in its mint, larger post-offices and coast-survey, while its extreme simplicity and the accuracy of its results have brought it into general use among scientific men.

THE METRIC IS SUPERIOR TO ANY OTHER SYSTEM
OF WEIGHTS AND MEASURES, BECAUSE;—

It is simpler ; the tables of length, surface, volume, capacity and weight being all based upon a single unit of length, the Meter, are readily understood and interchanged :

It is easily calculated by the decimal notation :

The value of each denomination is at once indicated by its *name* :

It aims at uniformity among all nations :

Its base is not subject to loss or variation.

TO PREVENT LOSS OR VARIATION.

The Meter, the Base of the entire System, was so designed that it could be verified in all places : *it is about One Ten-Millionth part of the Distance from the Earth's Equator to the Pole.*

After careful measurement of this distance on a meridian, its length was fixed and preserved at Paris in a bar of platinum, the least expansible of metals. Later calculations have proved that this measurement was inexact, but, the length being fixed and preserved beyond the possibility of loss, the value of the System is not impaired.

TABLE OF ESSENTIAL TERMS.

Use.	Name.	Pronunciation.	Derivation and Meaning.	Abbreviation.
Unit of length.....	Meter.	Meeter.	Greek, metron, a measure.	m.
" " capacity.....	Liter.	Leeter.	" " liter, a pound.	l.
" " weight.....	Gram.	Gram.	" " gramma, a small weight.	g.
" " land measure.....	Are.	Air.	Latin, area, a surface.	a.
" " wood measure.....	Stere.	Stair.	Greek, stereos, a solid.	s.
One thousand.....	Milli.	Milli.	Latin, mille, a thousand.	m.
One hundredth.....	Centi.	Senti.	" centum, a hundred.	c.
One tenth.....	Deci.	Desi.	" decem, ten.	d.
Ten.....	Deka.	Deka.	Greek, deka, ten.	D.
One hundred.....	Hekto.	Hekto.	" hekaton, a hundred.	H.
One thousand.....	Kilo.	Kilo.	" chilioi, a thousand.	K.
Ten thousand.....	Myria.	Miria.	" myrioi, ten thousand.	M.

LINEAR MEASURE.

TABLE.

10 Millimeters (mm.)	make	1 Centimeter.
10 Centimeters (cm.)	"	1 Decimeter.
10 Decimeters (dm.)	"	1 Meter.
10 Meters (m.)	"	1 Dekameter.
10 Dekameters (Dm.)	"	1 Hektometer.
10 Hektometers (Hm.)	"	1 Kilometer.
10 Kilometers (Km.)	"	1 Myriameter (Mm.)

This table is used for all measures of length ; the meter, like our yard, for measuring cloth and short distances ; the kilometer, for road measure.

REDUCTION OF LINEAR MEASURE.

One denomination may be reduced to another by changing the decimal point :

Thus 2381.278 meters = 2381278mm. or 2381278cm. or 23812.78dm. or 238.1278Dm. or 23.81278Hm. or 2.381278Km. or .2381278Mm.

Again, a quantity consisting of several terms may be written at once in terms of any one of them :

Thus 3Km. 2Hm. 5Dm. 7m. 9dm. 4cm. and 6mm. may be at once written 3.257946Km. or 32.57946Hm. or 325.7946Dm. or 3257.946m. or etc.

Or again, a quantity expressed in one denomination may be immediately broken up into several : thus 43262.425 meters = 4Mm. 3Km. 2Hm. 6Dm. 2m. 4dm. 2cm. and 5mm.

EXAMPLES.

1. Reduce 92818mm. to dm.; to m.; to Dm.; to Km.
2. Write 4Mm. 6Hm. 7m. and 8cm. as millimeters.
3. Express 2143928cm. in Km. Dm. and dm.
4. Reduce 3232.32m. to Mm.; to Hm.; to cm.
5. Write 3Mm. 4Km. 7Hm. 5Dm. and 6m. as meters.
6. Break 5070.0906 meters into Km. Dm. dm. and mm.
7. What is the value of 9Mm. 5Hm. 6m. 8cm. and 4mm. in cm.?
8. Express 9Hm. 4Dm. 1m. 5dm. 3cm. and 4mm. as m.; as Hm.
9. Write .0054829Mm. as m. and mm.; as Dm. and mm.
10. Reduce 446987 millimeters to cm.; to Dm.; to Km.
11. Reduce 323.18 decimeters to Mm.; to Hm.; to mm.
12. What is the value in cm. of 11Km. 14Dm. 23dm. and 16mm?
13. Write 32Mm. 116Dm. and 421mm. in meters.
14. Reduce 2.403Km. to mm.; to Dm.; to cm.
15. Express 12236 decimeters in Km. Hm. and mm.
16. What is the value of 62.034 kilometers in Hm. Dm. and m?

17. Reduce 1615.1 dekameters to dm. ; to Km. ; to mm.
18. Write 25Km. 34Dm. 18dm. and 28mm. in Hm.
19. What is the value of 860.15 meters in Km ? in Mm ? in mm ?
20. Express 23298.56 decimeters in Km. Dm. and cm.
21. Write 489 Km. and 392 cm. as Dm. ; as Hm.
22. Write 10305073.9mm. in as many denominations as possible.

TO ADD, SUBTRACT, MULTIPLY OR DIVIDE.

As the preceding reductions are simple, it follows that other operations are correspondingly simple. For, the given quantity or quantities may be at once reduced to the required denomination, and then treated according to the rules for simple numbers and decimal fractions.

Ex. 1. Add 1Mm. 3Km. 1Hm. 4Dm. 6m. 7dm. 9cm. 4mm. and 2Km. 5Dm. 3dm. 6mm.

13146.794 meters.

2050.306 "

15197.100 meters.

= 1 Mm. 5 Km. 1 Hm. 9 Dm. 7 m. 1 dm.

Ex. 2. Multiply 2 Km. 3 Hm. 7 Dm. 9 m. 6 dm.
2 cm. 5 mm. by 36.

2379.625 meters.

36

14277750

7138875

85666.500 meters.

= 8 Mm. 5 Km. 6 Hm. 6 Dm. 6 m. 5 dm.

Subtraction and Division may be performed in
a similar and equally simple manner.

EXAMPLES.

1. Write the sum of 7.478 Km. 423Dm. and
.079mm. in millimeters.

2. Add 2.7Mm., 135m., 7271dm., 185Hm., 90.21m.
and give their sum in the several denominations.

3. How many meters in 29cm. + 814Mm. +
302Dm. + 27Hm. + 3042mm?

4. Write in decimeters the value of 62743mm.
+ 4321m. + 7873.1cm. + .000076Km.

5. What is the sum of 6Km. 2Hm. 9Dm. 7m.
3dm. 5cm. + 3Km. 3m. 6cm. expressed in different
denominations?

6. How many hektometers in 73 Mm. + 25678
mm. + 21001dm. + 715Km.?

7. Add 2Dm. 6m. 8dm. and 1Km. 9Hm. 7Dm.
3m. 8dm. and give their sum in kilometers.

8. How many dekameters in $117064\text{cm.} + 929.73\text{Km.} + 82.7569\text{Mm.} + .008\text{m.}$?

9. Give in denominations the sum of $385842\text{m.} + 11281.7\text{mm.} + 3.2143\text{Km.} + 333.35\text{Dm.}$

10. Write the sum of 1143.12dm. , 87808mm. , $.3214\text{Dm.}$, 89.6Km. and $.87\text{m.}$ in myriameters.

11. Add 3Km. 5m. 7mm. , 4Hm. 6m. 2cm. , 6Hm. 3Dm. 9m. 3dm. 7cm. 5mm. and give their sum in denominations.

12. How many centimeters in 9Km. 9Hm. 3Dm. 9m. 9dm. 3cm. 9mm. $+ 4\text{Dm.}$ 1mm. $+ 2\text{Dm.}$ 6cm. ?

13. What is the difference in kilometers of 174.39m. and 41086.4dm. ?

14. Express in denominations the difference of 9.2Km. and 1m. 6dm. 8cm. 5mm.

15. How many decimeters in 84.2317Mm. — 435876cm. ?

16. Subtract $.79884\text{Hm.}$ from 1871.9dm. and write the difference in denominations.

17. From the sum of 1Mm. 3Km. 5Hm. 7Dm. 9m. 8dm. 7cm. 6mm. and 3Mm. 2Km. 8Dm. 1dm. 4mm. , subtract 5Km. 6Hm. 5Dm. 9m. 9dm. 8cm. and give the result in hektometers.

18. Give in meters the difference of 22724.38mm. and 33.29941Mm.

19. How many myriameters in the difference of 18.2416Dm. and 714.312Km. ?

20. What is the value in Dm. of 3828.43m — 312867mm. ?

21. Subtract 8Km. 6Hm. 9m. 3dm. 6mm. from 8Km. 6Hm. 1Dm. 4m. 3dm. 1cm. 6mm., and express the result in centimeters.

22. Express in denominations the diff. of .01029 Dm. and 8Km. 6Hm. 8Dm. 1m. 3cm. 4mm.

23. Multiply 4638.21m. by 345 and express in Dm.

24. Multiply 13.06mm. by 2538 and express in Hm.

25. Write in denominations the product of 2Km. 3Hm. 7Dm. 9m. 6dm. 2cm. 5mm. by .46.

26. How many centimeters in 4.6002Hm. $\times$ 11.90?

27. Write the product of 1.9774Mm. $\times$ 1.0006 in the different denominations.

28. How many decimeters in 81.201cm. multiplied by .0735?

29. Multiply 2.5394Dm. by 7.013 and write the product in millimeters.

30. Write in Mm. the value of 601.21dm. $\times$ 80704.

31. Express in denominations the result of 3Km. 2Hm. 5 Dm. 6m. 7dm. 4cm. 4mm. $\times$.325.

32. Multiply 234.578m. by 79 and write the product in denominations.

33. What is the value in centimeters of 3161.84 Dm. $\times$ 8.55?

34. Multiply 99 Km. by 99 and express in Hm.

35. How many kilometers in 4118dm. $\times$ 9.002?

36. Divide 8Dm. 5m. 7dm. 5cm. 5mm. by .003 and give the quotient in kilometers.

37. How many myriameters in the quotient of $40652640000\text{cm.} \div 846.93$?

38. What denominations in the quotient of 1164Dm. divided by 48.5 ?

39. Divide $8\text{Hm. } 4\text{Dm. } 3\text{m.}$ by $.003$ and express the result in myriameters.

40. Give the hektometers in $26645\text{Mm.} \div .73$.

41. How many millimeters in $3918\text{Dm.} \div 13.06$?

42. Express in meters the quotient of $2\text{Dm. } 7\text{m. } 9\text{dm. } 1\text{cm. } 8\text{mm.}$ divided by 11 .

43. Divide 59276.73dm. by 7.3 and give the result in the several denominations.

44. Divide $.07\text{Mm.}$ by $.04375$ and give the quotient in cm.

MISCELLANEOUS EXAMPLES.

1. Multiply 4617 meters by 12 , divide the product by 9 , add 3650 dekameters, from the sum subtract 6.56 hektometers and give the result in kilometers.

2. Divide the difference of 1296Km. and 4410Hm. by the sum of 360000mm. and 21000cm. , multiply the quotient by 20 and give the result in myriameters.

3. If a locomotive run 39000000m. in 13 weeks, how many Km. will it run in 364 days?

4. If a person travel in one direction 2005m. the first day, 1103010dm. the second, $.0069\text{Mm.}$ the third, 737500cm. the fourth, 225Dm. the fifth, and on the sixth day return 140Hm. , in how many days can he travel the distance that he then is from his starting point, at the rate of 9Km. a day?

5. A man has four rectangular tracts of land : the first is 1500000cm. long and 30000dm. wide ; the second, 8Km. long and 400Dm. wide ; the third, 180 Hm. long and. 6Mm. wide ; and the fourth, 250Hm. long and 1100Dm. wide. He has also an irregular tract the perimeter of which is 21079.8Km. He wants to enclose each tract with a fence four rails in height ; each rail being 1181.1dm. in length, how many will it require ?

6. The five-cent nickel piece is 20 millimeters in diameter ; how many, laid side by side, will reach 140 dekameters ?

7. A rectangular garden 1Hm. 7Dm. 5m. long and $12\frac{1}{2}$ Dm. wide has a walk around it 250dm. in width. How far in Km. will a person walk, walking the first day on the outer edge, the second, in the middle, and the third day on the inner edge of the walk, and going around the garden once each day ?

8. How many kilometers per hour does a person walk, who takes two steps a second and 1800 steps in a kilometer ?

9. Seven copper cents are nine millimeters in thickness ; how many dollars in this coin must be piled to reach to the height of 1Km. 8Hm. ?

10. A building is 2Dm. 6m. 5dm. high from the ground to the eaves, one side of its roof is 7 meters wide and the chimney rises 3m. 8dm. above the roof. How many dekameters in length is the lightning-rod which, sunk 1m. 2dm. in the earth, rises 2m. 5dm. above the chimney ?

11. A. can run a kilometer in $7\frac{1}{2}$ minutes and B. can run 7Km. 5Hm. per hour. They ran a race and the faster won in 24 minutes. How many hektometers was the loser behind?

12. After travelling $\frac{1}{4}$ of his journey, a traveller had 1Km. 6Dm. 8m. to go. How far in Km. Hm. etc. had he come?

13. The silver quarter-dollar is 2.4 centimeters in diameter. \$125000 in these coins, laid side by side, will extend how many kilometers?

14. A boy, having lost his kite, winds up the string and finds that $\frac{3}{8}$ of it are gone and 99 meters remain. What was the length of the string at first?

15. There is a park $3\frac{1}{2}$ Hm. long and $12\frac{1}{2}$ Dm. wide. Within the park and extending around it at a uniform distance of six meters from the fence is a walk 3m. wide. What is the entire length of the inner edge of the walk in hektometers?

16. If a bale of cotton weigh 500 lbs. and one-quarter pound will make a spool of thread containing 186m., what will the gross profit be on a bale of cotton at 10cts. per lb., manufactured into thread and sold at 4cts. per Hm?

17. In an orchard 6Hm. long and 19.2Dm. wide, the trees stand in regular rows at a distance of 4m. from each other, the outer rows being 8m. from the fence. How many trees in the orchard?

18. The half-dollar, silver coin, is 2 millimeters in thickness and the dime, half as much. If the latter be piled to the height of 1Hm. and the former, to the

height of 4Dm., which pile will contain the more dollars?

19. If each section of a water-main be 6m. in length and one lap the other 2dm. at the joint, how many sections will it require to conduct the main under 3.48Km. of roadway?

INTERCHANGE OF LINEAR MEASURES.

Equivalents.

- 1 Meter = 39.37 Inches.
- 1 Kilometer = .54 of 1 Knot or of 1 minute of Latitude (or of Longitude at the Equator).
- 1 Mile = 1.6093 Kilometers.

Caution.—The learner should have at ready command the tables of both systems. If other equivalents be used than those given, only approximate results will be obtained. In the examples given in this book, carry out the work to four decimal places only.

MISCELLANEOUS EXAMPLES.

1. Write the value of one yard in meters.
2. Write the value of one foot in decimeters.
3. Reduce one hektometer to rods, yards, feet and inches.
4. Reduce one kilometer to furlongs, rods, yards, feet and inches.
5. How many Mm. are there in four leagues?

6. Give the value of one dekameter in feet.
7. Give the value of one decimeter in inches.
8. Reduce 6 miles to Km., add 3.442Hm. and write in Mm.
9. How many fathoms in 9Dm. + 4.725 feet?
10. Add 6 miles and 2.3442Km., divide 13.2Mm. by their sum, add to the quotient 8.3116Km. and give the result in miles.
11. From a rope 5Dm. long, seven lengths of 47dm. each were cut. How many lengths of 11.22045 feet in the remainder?
12. Bought 78.74 yards of cloth for \$216; what was the cost per meter?
13. How many miles per day does a man travel, who walks 965.58 Hm. in six days?
14. A vessel leaves Callao and holds her course due west averaging 8.1 knots per hour. At the expiration of twenty days how many Km. from port is she?
15. If the "Tally-Ho" arrive at New Rochelle, having run 13589m. the first hour, and 1376.91Dm. the second, what is the average rate per hour in miles?
16. Chicago, Ill. is in 41° 53' 48" and Mobile, Ala. 30° 41' 26" north latitude; how many kilometers apart are they?
17. A rectangular field is 354.33 feet long and its length twice its width; what is the distance around it in meters?
18. A gentleman has a square garden whose side

measures 236.22 yards. He proposes to fence it, placing the posts two meters apart. How many posts will be required?

19. Albany, N. Y. is in $42^{\circ} 39' 50''$ and Montreal, in $45^{\circ} 31'$ north latitude; find the distance between them in kilometers.

20. A common lead-pencil is $1\frac{3}{4}$ decimeters in length; 32186 of them arranged in a line would extend how many miles?

21. A. Gillott's "303" pen is 3cm. 2mm. in length, How many of these pens arranged in a line would extend 38 rods, 2 feet and 11.04 inches?

22. St Petersburg is in $59^{\circ} 56'$ and Constantinople in $41^{\circ} 1'$ north latitude; how many Km. south from the former is the latter?

23. If an express train run $57\frac{1}{4}$ miles in two hours, how much time will it consume in running 1379 $\frac{3}{8}$ kilometers?

24. If there be 66 telegraph poles in one mile, how many will be required to construct a line 120Km. 6Hm. 9Dm. 7m. and 5 dm. long?

25. A. can build 20 yards of fence in a day, B. $\frac{3}{4}$ as much and C. 8 yards, 1 foot and 4.69 inches. How many days will the three consume in building 1Hm. 8Dm. and 5m. of fence?

26. A ship having cleared from New York sails eastward at the average rate of 9 knots per hour. How many Km. from port will she be at the expiration of two weeks?

27. While a boy is flying his kite the string breaks,

and, on winding it up, he finds that $\frac{1}{3}$ of it are lost ; 236.22 feet remain in his hand : how many meters long was the string at first ?

28. Copenhagen is in $55^{\circ} 41'$ and Rome, in $41^{\circ} 54'$ north latitude. How many kilometers apart are they ?

MEASURES OF SURFACE.

The Square Meter, a square whose side is 1 meter, is the unit of Surface Measure : it is used for measuring all ordinary surfaces as floors, ceilings, etc.

The Are or Square Dekameter, a square whose side is 10 meters, is the unit of Land Measure.

TABLE.

UNITS.—1 SQUARE METER AND 1 ARE (SQUARE DEKAMETER).

100 Sq. Millimeters (sq. mm.) make 1 Sq. Centimeter.

100 Sq. Centimeters (sq. cm.) “ 1 Sq. Decimeter.

100 Sq. Decimeters (sq. dm.) “ 1 Sq. Meter (sq. m.) or centare.

100 Sq. Meters or Centares (ca.) make 1 Are (a.) or Sq. Dekameter.

100 Ares or Sq. Dekameters (sq. Dm.) make 1 Hectare.

100 Hectares (Ha.) make 1 Sq. Kilometer (sq. Km.)

EXPLANATION.

Since Measures of Surface are squares, the scale proceeds by powers of 100 and each denomination occupies *two places*. A quantity may *therefore* be reduced by changing the decimal point *two places* for each denomination.

Thus $235469810 \text{ sq. mm.} = 2354698.1 \text{ sq. cm., or}$

23546.981 sq. dm., or 235.46981 sq. m. or ca., or 2.3546981 sq. Dm. or a., or .023546981 Ha.

Again, a quantity consisting of several terms may be at once written in terms of any one of them : thus 1 sq. Km. 3 Ha. 4 a. 6 ca. = 1030406 ca. or 10304.06 a. or 103.0406 Ha. or 1.030406 sq. Km. ; and 2 sq. m. 5 sq. dm. 27 sq. cm. 19 sq. mm. = 2.052719 sq. m. or 205.2719 sq. dm. or 20527.19 sq. cm. or 2052719 sq. mm. Conversely, a quantity expressed in one denomination may immediately be broken up into several : thus 23546798 ca. = 23 sq. Km. 54 Ha. 67 a. 98 ca. ; and 5030642 sq. mm. = 5 sq. m. 3 sq. dm. 6 sq. cm. 42 sq. mm. Examples, simplified by one of these processes, may then be treated as simple numbers and decimal fractions.

Ex. 1. Add 3 sq. Km. 4 Ha. 6 ca., 2 sq. Km. 27a. and 14 Ha. 2a. 3 ca.

$$\begin{array}{r}
 30400.06 \text{ ares.} \\
 20027.00 \text{ " } \\
 1402.03 \text{ " } \\
 \hline
 51829.09 \text{ ares.} \\
 = 5 \text{ sq. Km. } 18 \text{ Ha. } 29 \text{ a. } 9 \text{ ca.}
 \end{array}$$

Ex. 2. Add 9 sq. m. 7 sq. cm. 13 sq. mm., 15 sq. dm. 17 sq. mm. and 16 sq. m. 3 sq. mm.

$$\begin{array}{r}
 9.000713 \text{ sq. meters.} \\
 .150017 \text{ " } \\
 16.000003 \text{ " } \\
 \hline
 25.150733 \text{ sq. meters.} \\
 = 25 \text{ sq. m. } 15 \text{ sq. dm. } 7 \text{ sq. cm. } 33 \text{ sq. mm.}
 \end{array}$$

Ex. 3. Multiply 1 sq. Km. 13 Ha. 4 ca. by 25.

11300.04 ares.

$$\begin{array}{r} 25 \\ \hline 5650020 \\ 2260008 \\ \hline \end{array}$$

282501.00 ares.

= 28 sq. Km. 25 Ha. 1 a.

Ex. 4. Multiply 2 sq.m. 5 sq.cm. 13 sq.mm. by 48.

2.000513 sq. meters.

$$\begin{array}{r} 48 \\ \hline 16004104 \\ 8002052 \\ \hline \end{array}$$

96.024624 sq. meters.

= 96 sq. m. 2 sq. dm. 46 sq. cm. 24 sq. mm.

Ex. 5. Find the area of a tract of land 1 Km. 3 Dm. long and 2 Hm. 6 m. wide.

103 dekameters.

$$\begin{array}{r} 20.6 \quad " \\ \hline 618 \\ 206 \\ \hline \end{array}$$

2121.8 (sq. Dm.) ares.

= 21 Ha. 21 a. 80 ca.

Ex. 6. Find the area of a rectangle 1 m. 4 dm. 3 cm. long and 9 dm. 5 mm. wide.

1.43 meters.

$$\begin{array}{r} .905 \quad " \\ \hline 715 \\ 1287 \\ \hline \end{array}$$

1.29415 sq. meters.

= 1 sq. m. 29 sq. dm. 41 sq. cm. 50 sq. mm.

REDUCTION OF SURFACE MEASURE.

Examples.

1. Reduce 9080000 sq. cm. to ares ; 3 Ha. to sq. m.
2. Express 13 sq. Km. 54 Ha. 3 a. 47 ca. in sq. kilometers.
3. Reduce 19870000 sq. dm. to Ha. ; 11 ca. to sq. meters.
4. How many 403570 sq. mm. be written in denominations ?
5. Reduce 252700 sq. cm. to sq. Dm. or ares ; 5 sq. Km. to ares.
6. How many Ha. in 639860 sq. dm. ; sq. dm. in 17 ares ?
7. How many ca. in 754625 sq. cm. ; in 185 Hektares ?
8. Express 697305 ca. in the several denominations.
9. Reduce 19 sq. m. to centares ; .0006 Ha. to sq. centimeters.
10. Reduce 3 sq. m. 14 sq. dm. 6 sq. mm. to sq. decimeters.
11. Write 28 sq. Dm. in ares ; 639250 sq. cm. in sq. meters.
12. Break .843268 sq. Km. into denominations.
13. Reduce .016 sq. m. to sq. decimeters ; 7 a. to sq. centimeters.
15. How many ca. in 3 sq. Km. ; sq. dm. in 145 sq. cm. ?

15. Express 9.28764 sq. centimeters in denominations.
16. Give the value of 11.6 Ha. in ares; of 68 a. in sq. Km.
17. How many sq. Km. in 13820000 sq. cm.; sq. dm. in 9 sq. m.?
18. Express 1 sq. m. 1 sq. dm. 1 sq. cm. in sq. millimeters.
19. Write .0032 Ha. in sq. centimeters; .000096 sq. Km. in sq. dm.
20. Reduce 22274.46 sq. cm. to sq. Dm. or a.; 4780 sq. m. to a.
21. How many sq. Km. in 9128000 sq. dm.; sq. dm. in .0009 Ha.?
22. Reduce 48 ares to centares; .387295 sq. Km. to sq. cm.
23. Express 196.243 Ha. in denominations.
24. Write 13 sq. Km. 6 Ha. 7 a. 22 ca. in square meters.
25. Reduce 2120 ca. to Ha.; 3654.3200 sq. dm. to ares.

MISCELLANEOUS EXAMPLES.

1. How many square kilometers of land has a man who owns 42300 ares?
2. Add 49 Ha. 25 a., 28509 ca., 765.66 a. and give their sum in hektares.
3. How many square kilometers in 11332449 sq. dm., 4700 sq. cm., 17967.7504 a. and 308.99 Ha.?

4. Add 39 Ha. 74 a. 89 ca. to .000009011 sq. Km. and write their sum in square decimeters.

5. Write 1 sq. Km. 1 Ha. 1 a. + 100 sq. m. in hectares.

6. How many more ares in 1 sq. Km. than in 1 Ha?

7. Two dekameters square contain how many sq. Dm?

8. In a room are three windows: one contains 12 panes of glass, each of which is 6 dm. long and 4 dm. 5 cm. wide; each of the other windows contains 8 panes, each .5 m. long and 4 dm. wide. From how many square meters of glass may the whole be cut, allowing 1 sq. m. 56 sq. dm. for waste?

9. A park 3 Km. 4 Hm. 5 Dm. long and 3 Km. 6 Dm. and 5 m. wide is bounded by a road 4 Dm. in width. How many ares of ground does the roadway contain?

10. How many meters of carpet would be required for a room 11 m. 6 dm. long and 6 m. 1 dm. 6 cm. wide, the carpet being 8 dm. 12 mm. wide?

11. Give in denominations the area of a floor 7 m. 34 cm. long and 5 m. 2 cm. 5 mm. wide.

12. What will it cost to pave a street 6 Km. long and 14m. wide at 20cts. per square meter?

13. From two tracts of government lands, one containing 5sq. Km. and the other 390000 sq.m., the land agent reports 39Ha. as sold; how many sq. Km. in what remains?

14. An advertising company erect a sign-board

1Hm. long and 14m. high ; how much will they realize for the whole space, if they charge \$5 per sq. m. for advertising ?

15. How many cards 1.2dm. long and 5cm. wide may be cut from 12sq.m. of card-board ?

16. Around a square field containing .36Ha. of land is a board fence 2.5m. high. What will it cost to paint it at 10 cents per sq.m. ?

17. A gentleman's garden, which is square contains 81 ares : into how many square plats whose sides are 3Dm. may he divide it ?

18. A clothier has four pieces of cloth, each 62.5 m. long and 4.4dm. wide ; if a coat require 5sq.m. of cloth, how many can he cut from the whole ?

19. If a township be bounded by four highways, each of which is 8Km. long, and be subdivided into 32 equal sections, how many Ha. in a quarter-section ?

20. At 1 mill per sq.dm., what will it cost to paint a barn 1.2Dm. long, 9.5m. wide and 10m. high from the ground to the eaves, allowing .007sq.Hm. for both gable ends and deducting 240000 sq.cm. for the windows ?

21. A city has five parallel avenues, each of which is 352.8dm. wide. The first is 2.4Km. long ; the second, 212.3Dm. ; the third, 3.2Km. ; the fourth, 19.8Hm. and the fifth, 14220dm. What will it cost to pave them all at \$20 per. sq.Dm. ?

22. A farmer has a field containing 3.3Ha. of land which he intends to fence, placing the posts two meters apart. He calculates that the two longer

sides will require 222 posts including those at the corners. How many posts will be required for the two remaining sides?

23. If there are sixteen meshes in one square centimeter of mosquito-netting, how many meshes are there in a piece of netting 2.2Dm. long and 15dm. wide?

24. A field is planted with corn in regular rows, the outer rows being 4dm. from the fence and the hills the same distance from each other. On one side of the field are 424 hills and on its adjacent side 399 hills. How many ares of land in the field?

25. A daily paper consists of eight pages of six columns each and has a margin 36mm. wide. Each column is 6dm. long and 6cm. wide. How many sq. dm. of paper in the entire sheet?

26. On a checker-board there are sixty-four squares, half of them black and the other half white. If the board contains .16square meters, what is the side of one of the squares in centimeters?

INTERCHANGE OF MEASURES OF SURFACE.

Equivalents.

1 Square Decimeter=15.5 Square Inches.

1 Square Meter, or Centare, = 1.196 Square Yards.

1 Acre, or 160 Square Rods,=40.47 Ares.

MISCELLANEOUS EXAMPLES.

1. Find the square inches in a square whose side is .1m.

2. How many square decimeters in a square foot?
3. Reduce 750 centares to square yards.
4. Give the value of 1 square rod in square meters.
5. In one field are 6 acres, in another 4 acres and in a third 95a. 30ca.; how many Ha. of land in all?
6. Add 4000 sq. cm., 5sq. feet, 20sq. dm., 942sq. in. and reduce their sum to square yards.
7. A man who owns 60Ha. 47a. of land sells 100 acres; into how many fields of 50 ares each may he divide what remains?
8. Allowing .1sq. yd. for waste, how many square yards of muslin should be purchased to make 5 maps, each $2\frac{1}{2}$ m. long and 2m. wide?
9. Each link of the surveyor's chain is 7.92in. long and there are 100 links. How many sq.m. in 1sq. chain?
10. The two front windows of a store are each 336cm. long and 12.5dm. wide. What will it cost to fit them with plate glass at 75cts. per sq.ft., allowing 7.5834sq. feet for waste?
11. A garden is 16 rods long; how many meters wide must it be to contain one acre?
12. A township of government land is six miles square and one thirty-sixth constitutes a section. How many Ha. are there in a farm which embraces one-fourth of one section and 5 Ha. 24 a. 80 ca. of another?
13. A rectangular park has a walk around it 16.5

feet wide. The outer edge of this walk on one side of the park is $5\frac{1}{2}$ chains in length and on the adjacent side $2\frac{1}{2}$ chains. How many ares of land are there in the park?

14. A tract of land is 2 miles, 7 Hm. 8 Dm. 1 m. 4 dm. long and 1 mile, 39.07 Dm. wide. Into how many building lots of 80 a. each may the whole be divided?

15. If each infantry soldier carries one half of a shelter-tent and this half is 1.8 m. long and 1.5 m. wide, how many square yards of cloth will be required to supply a detachment of 275 men, allowing 111.97 sq. yds. for waste and hemming?

16. A florist has a parcel of land 206 ft. 8 in. long and 75 ft. wide. Into how many square beds whose sides are 1.2 Dm. may he divide it?

17. A house is 31 m. long and each side of its roof is 60 dm. wide. How many shingles will be required for the roof, if one shingle cover 20 square inches?

18. How many rods are there in one side of a square wheat-field which contains 36.423 hectares?

19. A gentleman's place consists of a square corner lot containing 1.21 Ha. Along the street fronts, he designs laying a brick walk 3.2 m. wide; how many thousand bricks 8 in. long and 4 in. wide will he require?

20. A California wheat-farm lies in the shape of a rectangle, the length being twice the width. A ploughman with his team leaves the house on the

edge of the farm in the morning, and, cutting the outer furrow at the rate of three miles per hour, reaches the house again at evening, after a day's work of ten hours. How many square kilometers are there in the farm?

21. How many reams of paper 40 in. long by 24 in. wide will be used in printing 4992 volumes of 240 pages each, each page being 1.8 dm. long and 12 cm. wide, allowing 6.52 sq. in. to a page for waste in trimming?

22. The floor of a hall is 117 ft. long and 75.9 ft. wide. What will it cost to cover it with Brussels carpet at \$2.10 per sq. meter?

23. What will it cost at 25 cents per sq. yd. to plaster a room, the specifications of which are as follows? It is 6 meters long, 4 meters wide and 3 meters high; has 4 doors 2 m. high and 1.5 m. wide, 4 windows 1.7 m. high by $1\frac{1}{2}$ m. wide and a wainscot 1.2 m. high; the bottom of each window being above the wainscot.

MEASURES OF VOLUME.

The Cubic Meter, a cube whose edge is 1 meter, is the unit of measures of volume : it is used for measuring all ordinary solids as masonry, excavations etc.

For measuring wood, the cubic meter is called a stere.

TABLE I.

UNIT.—1 CUBIC METER.

1000 Cubic Millimeters (cu. mm.)	make 1 Cubic Centimeter.
1000 Cubic Centimeters (cu. cm.)	" 1 Cubic Decimeter.
1000 Cubic Decimeters (cu. dm.)	" 1 Cubic Meter (cu. m.)

TABLE II.

UNIT.—1 STERE.

10 Decisteres (ds.)	make 1 Stere.
10 Steres (s.)	" 1 Dekastere (Ds).

EXPLANATION.

Since measures of volume are cubes, the scale proceeds by powers of 1000 and each denomination occupies *three places*. Hence a quantity may be reduced by changing the decimal point *three places* for each denomination.

Thus 3224687259 cu. mm. = 3224687.259 cu. cm.
or 3224.687259 cu. dm. or 3.224687259 cu. m.
Wood-measure proceeds by powers of 10 and is treated like Linear measure. (See pages 3, 4 and 5.)

Again, a quantity composed of several terms may be at once written in terms of any one of them; thus 41 cu. m. 134 cu. dm. 6 cu. cm. 29 cu. mm. = 41134006029 cu. mm. or 41134006.029 cu. cm. or 41134.006029 cu. dm. or 41.134006029 cu. m. Or again, a quantity expressed in one denomination may immediately be broken up into several: thus 2.345678908 cu. m. = 2 cu. m. 345 cu. dm. 678 cu. cm. 908 cu. mm.

When simplified as above, examples may be performed like simple numbers and decimal fractions.

Ex. 1. Add 13 cu. m. 28 cu. dm. 4 cu. mm., 6 cu. m. 19 cu. cm. and 2 cu. dm. 996 cu. mm.

$$\begin{array}{r}
 13.028000004 \text{ cu. meters.} \\
 .6.000019000 \quad " \\
 .002000996 \quad " \\
 \hline
 19.030020000 \text{ cu. meters.} \\
 = 19 \text{ cu. m. } 30 \text{ cu. dm. } 20 \text{ cu. cm.}
 \end{array}$$

Ex. 2. Multiply 2 cu. m. 16 cu. dm. 125 cu. mm. by 34.

$$\begin{array}{r}
 2.016000125 \text{ cu. meters.} \\
 \hline
 \quad \quad \quad 34 \\
 \hline
 8064000500 \\
 6048000375 \\
 \hline
 68.544004250 \text{ cu. meters.} \\
 = 68 \text{ cu. m. } 544 \text{ cu. dm. } 4 \text{ cu. cm. } 250 \text{ cu. mm.}
 \end{array}$$

Ex. 3. Find the contents of a stone 2 m. 8 dm. 3 cm. long, 6 dm. 2 cm. wide and 4 dm. 2 cm. 5 mm. thick.

$$\begin{array}{r}
 2.83 \text{ meters} \\
 .62 \text{ " } \\
 \hline
 566 \\
 1698 \\
 \hline
 1.7546 \text{ sq. meters.} \\
 .425 \text{ meters,} \\
 \hline
 87730 \\
 35092 \\
 70184 \\
 \hline
 .7457050 \text{ cu. meters.} = 745 \text{ cu. dm. } 705 \text{ cu. cm}
 \end{array}$$

REDUCTION OF MEASURES OF VOLUME.

Examples.

1. How many cu. meters in 45678 cu. centimeters?
2. Write 3 cu. m. 15 cu. dm. 2.6 cu. cm. in cu. decimeters.
3. How many steres of wood in 2500 cu. decimeters?
4. Reduce .8 cu. m. to cu. cm. ; 250 Ds. to ds.
5. Express 3223867.5 cu. mm. in denominations.
6. Write 4250000 cu. cm. in cu. m. ; 5.5 cu. m. in cu. mm.
7. Write 678 cu. meters in denominations of wood measure.
8. Reduce 16780 cu. dm. to cu. m. ; .18 cu. m. to cu. mm.
9. In 493682.73 cu. mm. how many cu. decimeters?
10. Write 25 cu. meters in ds. ; .0006 cu. m. in cu. mm.
11. Express 5 Ds. 8 s. 4 ds. in cu. meters.
12. In .35 cu. cm. how many cu. dm. ; ds. in 500 cu. dm.?
13. Write in denominations 80602004 cu. cm.
14. How many Ds. in 350 ds. ; how many cu. cm. in 1 s.?
15. Reduce .00535 cu. dm. to cu. mm. ; $\frac{1}{8}$ cu. cm. to cu. m.

16. In 26.7 dekasteres of wood how many ds. are there?
17. How many cu. cm. in .00812 cu. m. ; cu. dm. in $\frac{1}{4}$ cu m. ?
18. Express 68 cu. dm. 7 cu. cm. 19 cu. mm. in cu. dm.
19. Write 17 Ds. 3 s. 9 ds. in s. ; .002 $\frac{1}{4}$ Ds. in ds.
20. Reduce .0025 cu. mm. to cu. cm. ; $\frac{1}{8}$ s. to ds.
21. Express 2368.4975 cu. dm. in the several denominations.
22. Reduce 270 cu. cm. to cu. m. ; 18.23 cu. dm. to cu. mm.
23. In 9500000 cu. cm. how many cu. m. ; Ds. in 375000 cu. cm. ?
24. Reduce 650 Ds. to ds. ; 45 cu. meters to cu mm.
25. Write 54 cu. m. 23 cu. dm. 6 cu. cm. in cu. meters.
26. Write 8 cu. dm. 46 cu. cm. 133 cu. mm. in cu. dm.
27. Express 22.440962 cu. m. in denominations.
28. In 30355 cubic centimeters how many cu. dm. ?
29. Give the value of .76 cu. m. in cubic centimeters.
30. In 73.5 steres of wood, how many ds. are there ?
31. Give in cu. m. the value of 989897200. cu. cm.
32. Write in Ds. the value of 49767982 cu. dm.

MISCELLANEOUS EXAMPLES.

1. Write in cu. mm. 1 cu. m. 5 cu. dm. 4 cu. cm. and 8 cu. mm.

2. Find the value of 2 cu. m., 6 cu. dm., 1750 cu. cm. and 2250000 cu. mm. in cu. dm.

3. In 173250 cu. cm., 826 cu. dm. and 750000 cu. mm., how many cubic meters?

4. Write in cu. cm. the difference between 1 cu. dm. and 1 cu. m.

5. How many cu. cm. in 9.5 cu. m. + 5 cu. cm. + 445000 cu. mm. + 3.55 cu. dm.?

6. Subtract .2850 cu. cm. from .006 cu. m. and write the remainder in cu. dm.

7. What is the value in steres of 9 Ds. + 600 ds.?

8. What is the difference in cu. m. between 41995 cu. mm. and .000305 cu. dm.?

9. From 90.1 Ds. subtract 1 stere and give the remainder in ds.

10. Give in s. the value of 1889 cu. dm. + 211000 cu. cm.—100 cu. dm.

11. Multiply .3 cu. m. by 250 and give the product in steres.

12. What will be the cost of a pile of wood 8.6 m. long, 4.4 m. wide and 2.5 m. high at \$2 per stere?

13. How many cu. m. in two blocks of marble, one of which is .7 m. long, 170 dm. wide and 20 cm. thick, and the other 22 m. long, 3 dm. wide and 70 cm. thick?

14. Four wood-cutters are equal owners of a pile

of wood .08 Km. long, .14 Hm. wide and .25 Dm, high. They sell it at \$10 per Ds. ; how much does each realize?

15. A city lot contains .04 Ha. of land which the owner proposes to excavate to the depth of 7 meters for building. A contractor offers to do it for \$980; allowing $1\frac{1}{4}$ loads to the cu. m., what does he charge per load for the excavation?

16. A bin in a grain ware-house is 3.4 Dm. long, 3.4 m. wide and 18 dm. high. When filled with wheat, what will the wheat be worth at .05 dollars per cu. dm.?

17. An army corps build a line of earthworks 3 Km. 6 Hm. long, 8 dm. high and averaging 4 cm. 5 mm. in thickness ; how many cu. m. of soil compose the whole?

18. A tank .25 Dm. long, .24 m. wide and 48 dm. deep is filled with water, one cubic centimeter of which weighs one gram ; how many grams will the whole weigh?

19. A brigade of 3240 men builds a breastwork of logs 18 Hm. long, 1.8 m. high and 3.5 dm. thick. How many ds. of wood in what each man constructs?

20. A liter equals one cubic decimeter ; how many liters in a vat of wine 2.6 Dm. long, 7.5 m. wide and 2.2 m. deep?

21. Each of the two outer walls of an underground railway 3 Km. 4 Hm. 2 Dm. long is of solid masonry 8m. high and 8 dm. 2 cm. 5 mm. thick. These walls are built of blocks of stone 2 m. long, 2

m. wide and 7 dm. 5 cm. thick. How many blocks were required to build the walls?

22. What is the width in Hm. of a pile of wood 2 Dm. 6 m. long, 2 m. 5 dm. high, which contains 156 Ds.?

23. In a bridge are thirty-two girders of solid iron each of which is 6 meters long, 3 dm. 5 cm. wide and 2 dm. 5 cm. thick. How many cubic centimeters of iron in the whole?

24. The upper surface of a cubical cistern which holds 16000 liters of water measures 8 sq. meters. One liter being equal to one cu. decimeter, how many meters deep is the cistern?

25. If 20 pens are made from 1 cu. cm. of steel, how many may be made from a bar of the same metal .6 m. long, 4 dm. wide and 5 mm. thick?

26. A double-track railway is 2 Mm. 1 Km. in length. Each rail is 7 m. long, 1 dm. wide and 4 cm. thick; how many cu. meters of iron in the whole?

27. What will the wood on a piece of timber land containing 8 Ha. be worth at \$2 $\frac{1}{2}$ per stere, if there be one tree to every 5 sq. m. of land and each tree make 7 ds. of wood?

INTERCHANGE OF MEASURES OF
VOLUME.*Equivalents.*

- 1 Cu. Decimeter = 61.027 Cu. Inches.
- 1 Cu. Meter or Stere = 35.3165 Cu. Feet
1 Stere = .2759 Cord.
- 1 U. S. Liquid Gallon = 231 Cu. Inches.
- 1 U. S. Dry Gallon (half-peck) = 268.8 Cu. Inches.

MISCELLANEOUS EXAMPLES.

1. Give in cubic feet the sum of 138 cu. dm. and 84890.274 cubic inches.
2. What is the value in cu. meters of 5492.43 cu. in. + 43620 cu. dm. + 6290000 cu. cm.?
3. Write the difference of 1 cu. meter and 100 cu. decimeters in cu. inches.
4. From a pile of wood containing 12 cords, 12 steres were sold; how many cords remained?
5. How many cords of wood are there in two piles, one containing 4 cu. m. and the other 114.734 cu. feet?
6. In 1192.341 cu. dm. + .0038 cu. in., how many hhds. are there?
7. How many pecks are there in a bin which contains 6720 cu. decimeters?
8. Add 1.15 cu. meters to 241.918025 cu. feet and give their sum in cu. meters.
9. Find the length in meters of a pile of wood, 6.2 m. wide and 2.4 m. high, which contains 51.3174 cords.

10. A man, constructing a cistern to hold $35790\frac{1}{4}$ gallons of water, begins an excavation 25 feet long and 11 feet 8 inches wide; how many meters in depth must he make it?

11. Connected with a grain elevator is a room 20 feet long, 12 feet 2.4648 inches wide and 14 feet high. Since one cubic decimeter equals one liter, how many liters of grain in the room when filled?

12. Each of the two inner walls of an underground railway 8 Km. 1 Hm. long is of brick and is 8 m. high and 1 dm. 6 cm. thick. Twenty-seven common bricks make one cubic foot. How many thousand were required in constructing the walls, allowing 677.056 cu. feet for waste?

13. The Western Union Company has twenty direct wires from New York to New Haven, a distance of 75 miles. If one cu. decimeter of iron be drawn into .5 Dm. of such wire, how many cu. meters of iron in the whole?

14. A Western Steamboat has space for carrying 42 steres of wood which is filled from a pile on the river-bank 40 feet long, 8 feet wide and 8 feet high. How many cords remain in the pile?

15. A farmer has a rectangular tract of land containing 22.99 Ha. and extending $\frac{3}{4}$ of a mile along a river. Beginning at the end he digs drains 8 dm. wide .5 m. deep and 4.76 Dm. apart to discharge into the river. How many cu. meters of soil does he remove?

16. How many liquid gallons will a box 1.4 m. long, 1 dm. 1 cm. wide and 60 cm. deep contain?

17. A bin 2 m. 5 dm. long, 9 dm. wide and 4 dm. deep will contain how many bushels?

18. A gang of eight wood-cutters and a foreman agree with the owner to clear a tract of timber-land for half the wood. They agree to divide the profits equally and give their foreman two shares. When cut and piled to the height of 2 m. 5 dm., the wood covers 1 Ha. of ground. When sold for \$4 per cord what will the foreman realize?

19. The owner of some swamp-land designs raising $\frac{1}{2}$ acre of it to the height of 2 m. To obtain soil, he digs a drain 1 m. wide and 5 dm. deep. What will be its length in Km. Dm. and m.?

20. An embankment is 1 Hm. 2 Dm. long and 7 Dm. 5 m. wide. A contractor offers to cut it down to the depth of 6 m. and remove it for 10 cts. per cubic yard. What will it cost?

21. A mill-pond covers four acres and averages 2 m. 5 dm. in depth. Suppose it require 500000 liters of water daily to operate the mill and the pond can be drawn down two-thirds of its depth, how many days will the contents of the pond, when full, operate the mill, a liter being equal to one cubic decimeter?

22. Determine the cu. decimeters and cu. centimeters in a box 2 yds. long, 30 inches wide and 24 inches deep.

MEASURES OF CAPACITY.

The Liter, or cubic decimeter, *i. e.*, a cube whose edge is $\frac{1}{10}$ meter, is the unit of Measures of Capacity. It is used both for measuring liquids as wine, beer, milk etc., and dry substances, as grain etc.

TABLE.

UNIT.—1 LITER = 1 CU. DECIMETER.

10 Milliliters (ml.)	make	1 Centiliter.
10 Centiliters (cl.)	"	1 Deciliter.
10 Deciliters (dl.)	"	1 Liter.
10 Liters (l.)	"	1 Dekaliter.
10 Dekaliters (Dl.)	"	1 Hektoliter.
10 Hektoliters (Hl.)	"	1 Kiloliter (Kl.)

1 Milliliter (.001 of a liter) = 1 Cu. Centimeter (.001 of a cu. dm.)

1 Liter = 1 Cu. Decimeter.

1 Kiloliter (1000 liters) = 1 Cu. Meter (1000 cu. dm.)

In this measure the scale proceeds by powers of 10 and hence all operations in it are performed as in Linear Measure. (See pages 3, 4 and 5).

MISCELLANEOUS EXAMPLES.

1. Reduce .6 cl. to l. ; 41 l. to ml. ; 8.1 Dl. to dl.
2. Write 72 Dl. in cl. ; .3 Hl. in l. ; 1.6 l. in Kl.
3. Express 17093.478 l. in the several denominations.
4. Reduce 4 Kl. 6 Dl. 5 dl. 4 cl. to milliliters.
5. What is the value of 9 Kl. 9 Dl. 4 dl. 8 ml. in Dl?

6. In 516 dl. how many Hl. ; Kl. in 42516 cl. ?
7. Add 5 cu. decimeters 602 cu. centimeters, 488 cl., 6 l. 5 dl. 1 cl. 8 ml. and 3 cu. decimeters, giving their sum in Dl.
8. Reduce 6.176 cu. meters to cu. decimeters and write the result in denominations of capacity.
9. How many liters in the difference between 4 cu. meters and 45 hektoliters ?
10. Write 2 Kl. 6 l. and 4 ml. in cu. centimeters.
11. Add 4 Kl. 8 Hl. 6 Dl. 3 l. 9 dl., 5 Kl. 1 Hl. 3 Dl. 6 l. 1 dl., subtract 1 Kl. 2 Hl. 8 Dl. 6 l. and write the result in denominations.
12. How many liters in 9 cu. decimeters + 4 cu. meters + 1 cu. decimeter 540 cu. centimeters + 460 cu. centimeters ?
13. Add 1 dl. 6 cl. 8 ml., 4 dl. 8 cl. 2 ml., 3 l. 9.5 dl. and 5 l. 4 dl., multiply their sum by 835 and write the product in cu. meters.
14. Find the difference between 1 cu. meter and 1 hektoliter and write it in deciliters.
15. How many liters of water are there in a tank 8 m. 6 dm. long, 3 m. 2 dm. wide and 2 dm 5 cm. deep ?
16. Find the centares in the surface of a cistern which contains 169 Kl. 4 Hl. and is 8 m. 7 dm. 5 cm. in depth ?
17. How many sacks, each holding 7 dekaliters, may be filled from a bin of wheat 1.4 dekameters long, 840 centimeters wide and 65 decimeters deep ?
18. A vessel which will carry 11000 sacks of

grain, holding 64 liters each, is to be loaded from a store-room connected with an elevator; the floor of this room contains 1.76 square dekameters. To what height in meters must the room be filled with grain to load the vessel?

19. If one milliliter (one cubic centimeter) weigh a gram, how many thousand grams in a tank of water 4.9 meters long, 1 meter wide and .2 meters deep?

20. How long in Hm. and Dm. must a trough be made to hold 1.1 kiloliters, the inside surface of whose end is 5 square decimeters?

21. If 5 deciliters of sawdust be made in sawing .3 decistere of wood, how many kiloliters will be made in sawing into equal lengths a pile of wood 8 meters long, 6 meters wide and 24 decimeters high?

22. A. agrees to cradle a field of rye one and a quarter hektometers wide and receive in payment one-sixth of the grain; it takes him a half-hour to cross the field, while cutting a swath 2.4 meters wide, and he completes the task in 48 hours. If one hektare of land yields $6\frac{1}{4}$ hektoliters of rye, how many dekaliters will A. receive for his labor?

23. If lead be 11.35 times heavier than water and one milliliter of water weigh one gram, how many thousand grams will 8 dekaliters of molten lead weigh?

24. With an importation of goods from the East, comes a jar of the attar of roses 2 dm. long, 8 cm. wide and 5 cm. deep. What are the contents worth at \$2.50 per centiliter?

25. At 60 cts. per Dl., what is the value of a shipment of 20 car loads of wheat, each car being 5 m. long, 3 m. wide and 25 dm. high?

26. A city desiring to enlarge its water supply determines to increase the height of a dam 40 feet. It is estimated that each foot added to the height of the dam will give two million additional liters of water, and that one Kl. will flood 1 sq. m. of land. What will the land damage cost the city at \$5 per are.

27. Under the press of a cider-mill there is a cheese of ground apples $1\frac{1}{2}$ m. long, $1\frac{1}{2}$ m. wide and 8 dm. thick. If each cu. dm. of apples yield one liter of cider, how many Hl. will be obtained from the whole?

28. What is the depth of a tank that contains 540 kiloliters of water, the surface of whose bottom measures 2.7 sq. Dm.?

29. A barge 40 m. long, 6 m. wide and 4 m. deep is one-eighth filled with water when the leak is discovered. The men begin work at the pumps, which discharge $1\frac{3}{4}$ Hl. per minute, and in two hours have reduced the depth of the water $\frac{1}{2}$ dm. How many Kl. per hour flow in through the leak?

INTERCHANGE OF MEASURES OF CAPACITY.

Equivalents.

1 Liter=1 Cubic Decimeter=.908 Quart, Dry Measure,

1 Liter = 1 Cubic Decimeter = 1.0567 Quarts, Liquid Measure.

1 Cubic Decimeter = 61.027 Cubic Inches.

EXAMPLES.

1. Reduce one bushel to liters.
2. How many liters are there in one hogshead?
3. Reduce 2.84 kiloliters to liquid gallons.
4. What is the value in bushels of 4 kiloliters of grain?
5. In one liquid gallon how many liters?
6. How many hektoliters in 70 bush. 3 pecks and 6 quarts?
7. Reduce 167 hogsheads 46 gallons to kiloliters.
8. Give in bushels, pecks and quarts the value of 6Kl. 5Hl.
9. Reduce 40 kiloliters + 50 hectoliters to hogsheads, gallons, quarts and pints.
10. Add 24.9 quarts to 325 liters and give their sum in bushels.
11. What is the value in gallons of 1 bbl. + 4 $\frac{1}{8}$ gallons + 25000l?
12. From 30 bushels of grain 8 hektoliters were taken; how many bushels, pecks and quarts remained?
13. From .50765 hogshead of wine, 34l. were drawn; how many gallons remained?
14. What is the capacity in U. S. liquid measure of a cistern 4 meters long, 3 meters wide and 8 meters deep?

15. There is a pond 125 feet long, 61.027 feet wide with an average depth of 5 feet; what is its capacity in kiloliters?

16. Since one milliliter of water weighs one gram and a metric ton equals one million grams, how many metric tons will the above amount of water weigh?

17. How many sacks holding 5 dekaliters each may be filled from a storehouse of grain 125 feet long, 122.054 feet wide and 25 feet high?

18. There is a bin of wheat .8 dekameters long, 3 meters wide and 20 decimeters deep; how many sacks holding 2 bushels each may be filled from it?

19. The fount of an illuminating lamp is 1 foot 6.3081 inches long, 10 inches wide and 4 inches deep. How long will the lamp burn when filled, if it consume 8 deciliters of oil per hour?

20. From 30 hogsheads of wine 410.62 gallons were sold; what is the remainder worth at 50 cents per liter?

21. If a tank be 2.4 m. long, 1.5 m. wide and 1 m. deep, and the service pipe will deliver 21.134 quarts every five minutes and the waste pipe discharge 15 liters in the same time; how long will it take to fill the tank when empty, both pipes being opened at the same time?

22. What must be the length of a box in meters to contain 11.35 bushels, if it be 1 m. wide and 2 dm. deep?

23. A tank which holds 4.54 bushels of grain will hold how many Hl. and Dl. of water?

24. The leak in a sunken vessel being stopped and the water pumped out at the rate of 2 hogsheads per minute, she is freed from water in 5 hours 17.01 min. How many hektoliters will she hold when filled with grain?

25. A wine-grower produces a vat of wine which covers 1.8 ares of ground and which is 2.5 m. deep. To ship the contents to the United States, how many tierces will he require, allowing 60.75 gallons for shrinkage?

26. A farmer hires a number of wood-cutters and, besides their wages, agrees to give them a liter of cider for each stere of wood that they cut and pile. When they have finished, the pile contains 1103.6 cords; how many Hl. of cider are due them?

27. A wheat-farm containing 80.94 Ha. of land yields 22.7 bushels of wheat to the acre. What will the crop when harvested be worth at \$1.60 per double-dekaliter?

28. A Mississippi river flat-boat 122.054 ft. long, 25 ft. wide and 6 feet deep, laden $\frac{4}{5}$ of her depth with oats at St. Louis, floats down the river to New Orleans. On her arrival there, the owners sell the oats at \$1.10 per Hl., how much do they realize?

WEIGHT.

The unit of weight is a cubic centimeter of distilled water at 4° centigrade, or 39 $\frac{1}{4}$ ° Fahrenheit, and is called the gram. It is used for weighing all substances.

TABLE.

UNIT.—1 GRAM = 1 CU. CENTIMETER = 1 MILLILITER.

10 Milligrams (mg.)	make	1 Centigram
10 Centigrams (cg.)	"	1 Decigram.
10 Decigrams (dg.)	"	1 <i>Gram</i> .
10 <i>Grams</i> (g.)	"	1 Dekagram.
10 Dekagrams (Dg.)	"	1 Hektogram.
10 Hektograms (Hg.)	"	1 Kilogram.
10 Kilograms (Kg.)	"	1 Myriagram.
10 Myriagrams (Mg.)	"	1 Quintal.
10 Quintals (Q.)	"	1 Ton (M. T.)

NOTE.—To avoid confusion with our ton, the ton is here abbreviated M. T. for metric ton.

1 Cubic Centimeter	=	1 Milliliter	=	1 Gram.
1 Cubic Decimeter	=	1 Liter	=	1 Kilogram.
1 Cubic Meter	=	1 Kiloliter	=	1 Metric Ton.

All operations under this table are the same as in other scales proceeding by powers of 10.

EXAMPLES.

1. Reduce .3 M.T. to centigrams; 4 Hg. to myriagrams.
2. Write 2 dg. 1 cg. 5 mg. in Dg.; 328.80 dg. in denominations.
3. Give the value of 2.6 Q. in mg.; 4.45 Dg. in Mg.
4. What is the value of 4520 Kg. in M. T.; of 8 mg. in cg.?
5. Reduce 9295 dg. to Dg.; 44775 cg. to denominations.
6. What is the value of 879986 dg. in Q.; of 8 Mg. in mg.?

7. Write 2.8 Hg. in cg. ; .8 Kg. in dg. ; .68 Q. in g.
8. Give the value of 1820 g. in Kg. ; of 27485 g. in M. T.
9. What is the sum in Kg. of .2.26 Dg. + 1.4528 Hg. + 16.992 g. + 151.28 dg. ?
10. Write 4 M. T. 6 Q. 7 Mg. 8 Kg. and 5 Hg. in grams.
11. Give 6 Dg. 4 g. 3 dg. 6 cg. in milligrams.
12. Add 242260 mg., 3267.89 g., 892645 cg., 73589.2 dg., 448.461 Dg., 57.1987 Hg. and give their sum in Mg.
13. Add 4195 g., 478.2 Hg., 4.253 mg., 2365 Dg., 36.98 Kg., 189600 dg., 7.8811 Q. and give the result in M.T.
14. To 38.54 Q. add 5800 Dg., subtract from their sum 4120 Hg. and write the result in Kg.
15. From 4 M. T. + 16 mg. + 224 Hg. + 86 g. subtract 48.6 Dg. + 82 Kg. + 1 Q. and write the difference in Q.
16. Multiply 182 Kg. + 44 Dg. by 5 and write the product in Hg.
17. Multiply 2886 mg.—26.2 dg. by 4 and give the result in denominations.
18. What is the value of $(252 \text{ cg.} \times 81) - (70.2 \text{ dg.} \div 27)$ written in denominations?
19. Divide 3.4 M.T. by 17 and give the quotient in Kg.

NOTE.—The gold and silver coins of the U. S. are .9 pure metal and .1 alloy. The alloy of the gold coins is silver and copper ; the silver being .1 of the alloy, or .01 of the whole coin,

and the copper .9 of the alloy, or .09 of the coins. The alloy of the silver coins is pure copper.

The five-cent and three-cent pieces are $\frac{2}{3}$ copper and $\frac{1}{3}$ nickel.

The cent is .95 copper and .05 tin and zinc.

Carat, applied to the fineness of gold, means one twenty-fourth part.

20. The nickel five-cent piece weighs 5 grams : what is the weight in Dg. of the copper in \$12 of such coin ?

21. A druggist buys 1 Kg. of quinine for \$60 and sells it at 2 cts. per dg. What are his profits on the whole ?

22. A jeweller has a bar of gold 12 dm. long, .5 dm. wide and 5 cm. thick. He manufactures it into watch-chains which weigh 3 Dg. each and sells them at \$20 apiece. How much does he receive for all, gold being 19.25 times heavier than water ?

23. The silver half-dollar weighs $12\frac{1}{2}$ grams ; how many may be coined from 27 Hg. of pure silver, making due allowance for the alloy ?

24. How much will a merchant receive for 2 metric tons of flour which he sells at \$10 per Q. ?

25. A dealer invests \$7000 in coal at \$3.50 per M.T. and sells it at \$5 per M.T. What are his profits ?

26. The silver twenty-cent piece weighs 5 grams. How many dollars in such pieces may be coined from a bar of pure silver 3 dm. long, 1 dm. wide and 3 cm. thick (the specific gravity of silver being 10.47 and the proportion of alloy being given above) ?

27. Our ten-cent piece weighs $2\frac{1}{4}$ grams, our twenty-cent piece 5 grams and our fifty-cent piece $12\frac{1}{4}$ grams: how much in grams will \$5 in any or all of these coins weigh?

28. Upon the above basis, what are our silver coins worth per g.?

29. From the facts ascertained, determine the weight of our silver dollar; of our quarter-dollar.

30. How many metric tons will the contents of a tank weigh which contains 45 hektoliters?

31. A cistern which covers 4 centares of ground and is 5 m. deep will contain how many Mg. of water?

32. A mill is erected at a distance of 25 m. from the pond containing its water supply and a mill-race 3 m. wide and 6 dm. deep is to connect the two. The builder mentally calculates the weight of water in the race when full, in order to properly support it; how many M.T. does he find it to be?

33. The pond which supplies the above mill covers 2.2116 Ha. of land, has an average depth of 2.5 m. and a stream feeding it which delivers an average of $1\frac{1}{2}$ Hl. per minute. Suppose now the overshot wheel to make 5 revolutions per minute and to require one metric ton of water per revolution, how many days of ten hours each can the owner operate the mill, no rain falling meanwhile?

34. If maple be .75 as heavy as water, what will be the weight in M.T. of a log of such wood containing .4 Ds?

35 A bar of steel weighing 8 Kg. being made into 40000 needles, what will each needle weigh in cg?

36. One wall of a building composed of granite, is 8 m. long, 6 m. high and .5 m. thick. What will it weigh in M.T., granite being 2.65 heavier than water?

37. How many Hl. in a cask that contains .8 M. T.?

38. During a storm, if $2\frac{1}{2}$ cm. of water fall on the level, how many metric tons of water fall on .6 Ha. of land?

39. A merchant invests \$900 in coffee at 75cts. per Kg. and sells it at $\$1\frac{1}{2}$ per demi (half)-Kg.; what are his profits?

40. On the land owned by a Pennsylvania Coal Co. is a seam of anthracite coal 2 Km. long, 4 Hm. wide and averaging 6 m. thick. Anthracite coal being 1.5 heavier than water, how many metric tons can the company mine from this seam?

41. An apothecary buys a bottle of quinine containing 3 Dg. How many doses of 3 dg. each can he prepare from it?

42. Steel being 7.8 heavier than water, how many "303" pens, which weigh 3 dg. each, may be manufactured from a bar of steel 1 m. long, .5 dm. wide and 1 cm. thick, making no allowance for waste?

43. The N. Y. Central and Hudson River R.R. controls and operates 3980 Km. of track which weighs 321 Kg. per meter. What is the total weight in metric tons of their track?

44. If a bar of gold 1 dm. long whose end measures 1 sq. cm. be wrought into gold pens, which weigh 5 dg. and sell for \$ $2\frac{1}{2}$ each, the specific gravity of gold being 19.25, what will their sale realize?

INTERCHANGE OF WEIGHTS.

Equivalents.

- 1 Gram = 1 Cu. Centimeter = 15.432 Grains
- 1 Kilogram = 1 Cu. Decimeter = 2.2046 Pounds Avoir.
- 1 Metric Ton = 1 Cu Meter = 2204.6 Pounds Avoir.
- 5760 Grains = 1 Pound Troy or Apoth. Weight.
- 7000 Grains = 1 " Avoirdupois "
- 175 lbs. Troy = 175 lbs. Apoth. = 144 lbs. Avoir.

EXAMPLES.

1. Reduce 1 oz. Troy to grams; 1.286 Apoth. oz. to grams.
2. Give the value of 1 lb. Av. in Kg.; of 1 lb. Troy in Hg.
3. What is the value of 1 grain in milligrams?
4. Reduce 2.5 Hg. to Troy oz.; 6 Hg. to Apoth. lbs.
5. Reduce 144 dg. to pwt.; 1.929 scruples to Dg.
6. What is the value of 1 Kg. in Troy or Apoth. lbs?
7. Give the value of 1 quintal in Avoir. lbs.
8. Reduce 1 Mg. to Avoir. oz.; to Troy or Apoth. ounces.
9. In 2 metric tons how many lbs. Troy or Apoth. ?

10. Reduce 2.572 drams to grams.
11. In 2500 metric tons how many tons?
18. In 661.38 cwt. how many quintals are there?
13. How many lbs. Troy or Apoth. in 2.52 metric tons?
14. How many more dekagrams are there in one pound of feathers than in one pound of gold?
15. The trade-dollar weighs 420 grains; how many Mg. in \$2572 of such coin?
16. A chemist manufactures 13.2276 avoird. lbs. of quinine, which he puts up in bottles holding 3 Dg. each, and sells at \$2.50 per bottle; how much does he receive for the whole?
17. What amount of money will a jeweller realize from 45 Kg. of gold wrought into rings 18 carats fine, weighing 5 pwt. each, which he sells at \$4 apiece?
18. Making due allowance for the alloy, how many dollars in U. S. double-eagles, weighing 516 grains each, may be coined from 1161 Hg. of pure gold?
19. At the foot of a staircase stands a newel-post of lignum-vitae $1\frac{1}{2}$ m. high, whose end measures 25 sq. dm. Lignum-vitae being $1\frac{1}{2}$ times heavier than water, how many cwt. will the post weigh?
20. Maple being $\frac{3}{4}$ as heavy as water, what will be the weight in tons of 15 sticks of such timber, each of which is 20 m. long, 6 dm. wide and 6 dm. thick?
21. A seine 118.11 fathoms long has a line of cubical corks whose edge is 1 dm. to float its top,

and a line of leads .5 dm. square and .4 dm. thick to sink the bottom. Beginning at the end, the floats 1 m. apart and the leads 3 m. apart extend the entire length. The specific gravity of cork being .24 and of lead 11.35, how many more lbs. will the sinkers weigh than the floats?

22. A farmer has a field 197.34 ft. long and 180 ft. wide planted with rye. If each are of land produce 1 Dl. of rye and each liter weigh $2\frac{1}{2}$ Kg., how many cwt. of rye does the field produce?

23. There were used in the construction of a certain bridge 400 solid iron beams, each 28.2532 ft. long and its end containing .25 sq. ft. Iron being 7.78 heavier than water, what was the total weight of the beams in tons?

24. A cabinet maker used 3 timbers of cherry, each containing .5518 cord, in making furniture. The specific gravity of cherry being .715, how many tons of it did he use?

25. How many U. S. eagles which weigh 258 grs. each may be coined from 5805 Hg. of pure gold, making proper allowance for the alloy?

26. A jeweller manufactures 2 bars of gold, each 24.4108 in. long and its end containing 5 sq. in., into watch-chains 14 carats fine and weighing 36 pwts. each. Allowing 336 grains of gold for waste, gold being 19.25 times heavier than water, how many chains are wrought from the bars?

27. A druggist buys a quantity of gum-arabic for \$72.50, which fills a double-dekaliter jar, and sells it

at 5 cts. per dram. Gum-arabic being 1.45 times heavier than water, allowing 528 grains lost by overweight, what are his profits on the whole?

SUMMARY OF TABLES.

LENGTH.		SURFACE.	
10 mm.	make 1 cm.	100 sq. mm.	make 1 sq. cm.
10 cm.	" 1 dm.	100 sq. cm.	" 1 sq. dm.
10 dm.	" 1 m.	100 sq. dm.	" 1 sq.m. or ca.
10 m.	" 1 Dm.		
10 Dm.	" 1 Hm.	II.	
10 Hm.	" 1 Km.	100 ca.	make 1 a.
10 Km.	" 1 Mm.	100 a.	" 1 Ha.
		100 Ha.	" 1 Sq. Km.

VOLUME.

I.		II.	
1000 cu. mm.	make 1 cu. cm.	10 ds.	make 1 s.
1000 cu. cm.	" 1 cu. dm.	10 s.	" 1 Ds.
1000 cu. dm.	" 1 cu.m. or s.	10 s.	" 1 Ds.

CAPACITY.

10 ml.	make 1 cl.
10 cl.	" 1 dl.
10 dl.	" 1 l.
10 l.	" 1 Dl.
10 Dl.	" 1 Hl.
10 Hl.	" 1 Kl.
10 Kl.	" 1 Ml.

WEIGHT.

10 mg.	make 1 cg.
10 cg.	" 1 dg.
10 dg.	" 1 g.
10 g.	" 1 Dg.
10 Dg.	" 1 Hg.
10 Hg.	" 1 Kg.
10 Kg.	" 1 Mg.
10 Mg.	" 1 Q.
10 Q.	" 1 M. T.

SUMMARY OF EQUIVALENTS.

LENGTH.

- 1 Meter = 39.37 Inches.
 1 Kilometer = .54 of 1 Knot or of 1 Minute of Latitude (or
 of Longitude at the Equator).
 1 Mile = 1.6093 Kilometers.

SURFACE.

- 1 Sq. Decimeter = 15.5 Sq. Inches.
 1 Sq. Meter or Centare = 1.196 Sq. Yards.
 1 Acre, or 160 Sq. Rods, = 40.47 Ares.

VOLUME.

- 1 Cu. Decimeter = 61.027 Cu. Inches.
 1 Cu. Meter or Stere = 35.3165 Cu. Feet.
 1 Stere = .2759 Cord.
 1 U. S. Liquid Gallon = 231 Cu. Inches.
 1 U. S. Dry Gallon (half-peck) = 268.8 Cu. Inches.

CAPACITY.

- 1 Liter (1 Cu. Decimeter) = .908 Quart Dry Measure.
 1 Liter (1 Cu. Decimeter) = 1.0567 Quart, Liquid Measure.

WEIGHT.

- 1 Gram (1 Cu. Centimeter) = 15.432 Grains.
 1 Kilogram (1 Cu. Decimeter) = 2.2046 Pounds Avoir.
 1 Metric Ton (1 Cu. Meter) = 2204.6 Pounds Avoir.
 5760 Grains = 1 Pound Troy or Apoth. Weight.
 7000 " = 1 " Avoirdupois "
 175 lbs. Troy = 175 lbs. Apoth. = 144 lbs. Avoir.

GRAVITY.

Gravity is the force with which all bodies are drawn towards the earth's centre.

Weight is the measure of that force.

Specific gravity is the weight of a body compared with the weight of an equal volume of another body, taken as a standard.

Distilled water is the *standard* for solids and liquids; hydrogen, for gases.

TABLE OF SPECIFIC GRAVITIES.

Distilled Water, the Standard, 1.

Platinum.....	21	Marble.....	2.72
Gold.....	19.25	Granite.....	2.65
Mercury... ..	13.5	Slate.....	2.11
Lead.....	11.35	Sugar.....	1.6
Silver.....	10.47	Anthracite Coal.	1.5
Copper.....	8.90	Lignum-vitæ....	1.33½
Nickel.....	8.28	Ice.....	.93
Steel.....	7.82	Maple.....	.75
Iron in bars.....	7.78	Cherry ...	.715
Cast Iron.....	7.20	Pine.....	.66⅔
Diamond.....	3.50	Cork.....	.24
Glass.....	2.76		

By the metric system, the dimensions or volume of a body being given, its weight is easily ascertained : find the weight of an equal volume of water, multiply it by the specific gravity of the substance whose weight is sought and reduce the result to the required denomination.

MISCELLANEOUS PROBLEMS.

1. A cistern whose length is twice its width or depth contains 54 metric tons of water ; what are its dimensions ?
2. John can throw a ball $\frac{3}{4}$ as far as James and

$\frac{3}{4}$ as far as Henry. James passes it from John to Henry and back again to John. The ball travels in all 472.44 yards; how many meters can Henry throw it

3. How many hhds. and gals. of wine will fill a tank that holds 440 bushels of grain?

4. With a bar of nickel 5 decimeters long, $2\frac{1}{2}$ decimeters wide and 20 centimeters thick, how many dollars in five-cent pieces may be coined?

5. An Ice Co. cut and store a supply of ice from a surface of water covering 2 hectares, each block being 5 decimeters thick. If they lose one-fourth by shrinkage and sell the remainder at 50 cts. per hundred-weight, what will they realize?

6. A building is 40 feet long, 18 feet wide and 20 feet in height from the ground to the eaves and 32 feet from the ground to the point of the gable. In shingling its roof, the carpenters use three ladders; the foot of the first is on the ground 9 feet from the building and its top resting against it 8 feet from the eaves; from the top of this, the second extends perpendicularly to the eaves and the third from the eaves to the peak of the roof. What is the entire length of the ladders in meters?

7. When the three service pipes which supply a tank are open, they fill it in five hours. The smallest pipe will fill it in 20 hours, the next larger in fifteen hours and the largest delivers 25 liters every five minutes. How many hundred-weight of water are there in the tank when filled?

8. From a bar of silver 2 ft. .4108 inches long, $2\frac{1}{2}$

inches wide and $2\frac{1}{4}$ inches thick, how many dollars in silver twenty-cent pieces may be coined?

9. What must be the length in dm. of a bar of pure copper 2.5 cm. in width and thickness, to furnish the legal amount of alloy for \$178000 in twenty-cent pieces?

10. Eighteen men contract to build a road. When it is $\frac{1}{4}$ done, they employ 6 more men, and when $\frac{3}{4}$ done, 8 more men. Each of the 18 men builds in all $262\frac{1}{2}$ dekameters. What is the length of the road in metric denominations?

11. A thermometer has a glass tube 3 mm. square on the inside and 1 m. long, which is filled with mercury to the height of 2 dm. How many grains does the mercury weigh?

12. The cable of a ship parted and, when hauled in, $\frac{3}{8}$ of it were gone; 75 meters of cable were spliced on but failed to reach bottom; 18.99 fathoms remained on the ship and soundings showed that if this were added, the cable would be $\frac{5}{8}$ of its original length. How many feet long was the cable at first?

13. If a druggist buy 252 hundred-weight of borax at 40 cts. per. pound and sell it at the same price by Apothecaries' weight, what will be his profit on the transaction?

14. A field of oats 328.9 yards long and 264 yards wide yields 85 bushels per hektare. What is the total amount in bushels, pecks and quarts harvested from the field?

15. A certain race-course is 4.2 kilometers in circumference. A. and B. start together to walk around it in the same direction. When A. has walked 1.05 hektometers, $\frac{3}{17}$ of the distance that B. has walked represents his gain on A. How many times will each complete the circuit before B. overtakes A ?

16. In a block of copper 15 inches long, 12.2054 inches wide and 3 inches thick, there is the legal amount of alloy for how many silver dollars ?

17. How many steres are there in a hewn stick of maple timber which weighs 33 tons 1 hundred-weight and 38 pounds ?

18. A polo-player, having ridden one-fourth the distance across the field, returns half-way, strikes the ball and follows it to the centre of the field ; thence riding back again, he strikes the ball at the place where first he struck it, and, driving it across the field, wins the game. He has ridden in all 7874 yards ; what is the length of the field in hektometers ?

19. If 5.518 double-deciliter of sawdust were made in sawing one stere of maple into certain lengths, how many cords were sawed into the same lengths to produce a pile of sawdust weighing 661.38 hundred-weight ?

20. How many Troy ounces will a platinum meter-bar weigh, whose end measures one square centimeter ?

21. If the iron in a single-track street railway weigh 626.0177 metric tons and each rail be 8 centi-

meters wide and $6\frac{1}{4}$ centimeters thick, what is the length of the road in miles?

22. Making no allowance for the thickness of the walls, how many acres of ground does a factory cover whose ground floor contains 5396 quintals of pine boards 4 centimeters thick?

23. If a mould be made with a silver dollar and the impression filled with molten lead, what will be the weight of the counterfeit in grams?

24. Connected with a sugar-house is a drying-room 70.633 feet long and 24 feet wide which is filled with sugar to the depth of two feet. How many hektoliters of sugar are there in the room?

25. What will the sugar in the above room weigh in tons, hundred-weight etc.?

26. A druggist melts a quantity of wax and with it fills a double-dekaliter jar. How much will the sale of the whole yield him at five cents per ounce, the specific gravity of this wax being .95?

27. The berths of a steamer 2 yards long and 1.794 yards wide are fitted with cork mattresses 1 decimeter in thickness. There being two berths in each of the 150 state-rooms on the vessel, what is the united weight of these mattresses in tons, hundred-weight etc.?

28. If two kilograms of opium be divided into doses of 1 scruple 8 grains each and sold at 25 cents per dose, what will the receipts from its sale amount to, allowing 64 grains lost by overweight?

29. There is a building 100 feet long and each

side of its roof 31 feet wide. The roof is covered with slates $2\frac{1}{2}$ millimeters thick, each of which weighs 9.303412 pounds. Three-fourths of each slate being exposed to the weather, what is the total number of them on the roof?

30. A vessel clears from Turks Island for New York with a cargo of 5811.2 bushels of salt. On her arrival there the salt is sold at 45 cents per hundred-weight. The specific gravity of salt being 2.13, how much do its consignees realize?

31. There are four ladders of different lengths, in each of which the rungs are $\frac{3}{4}$ meter apart and the top and bottom rungs the same distance from the ends. The first has 35 rungs, the second, 30, the third, 24, and the fourth, 17. When spliced together, the bottom rung of one resting on the end of the ladder below, to what height in feet will they reach?

32. A box 2 decimeters deep whose upper surface contains 3.1 square feet is filled with moulder's sand. The pattern of a stove-grate is then imbedded in it and the surplus sand brushed off. Into the impression thus formed 2 liters of molten iron are poured. The specific gravity of the iron being 7.20 and of the sand 1.5, what will the contents of the box weigh in hundred-weight, pounds and ounces?

33. The longitude of Alexandria, Egypt, is $29^{\circ} 53'$ East. A vessel clears from that port for New York and when some weeks out an observation shows her longitude to be $25^{\circ} 1'$ West. Supposing the

distance between the two ports to be 12650 Km., how many kilometers from New York is she?

34. A man travels two hours by rail 24 miles per hour, three hours by stage eight miles per hour and then walks 19.3116 kilometers to his destination in three hours. How long will he be in walking back the entire distance?

35. A man, horse and dog walk 99 kilometers each; if the man step 2 feet 6 inches, the horse, 2 feet 9 inches and the dog, 9 inches, how many more steps does the dog take in the entire distance walked than the man and horse together?

36. A merchant buys a certain number of bushels of oats and with them fills a bin the bottom of which measures 211.899 square feet. He sells at one time $\frac{1}{3}$ of them, then $\frac{1}{3}$ of what remains and again $\frac{1}{4}$ of the remainder and 15 kiloliters of oats remain in the bin. How many feet deep is the bin?

37. If $\frac{2}{3}$ of a pile of pine wood be consumed and there remain 11 hundred-weight 2 pounds and 4.8 ounces, how many dekasteres were there in the pile at first?

38. If a block of pure gold be rolled into a sheet 1 millimeter in thickness which will cover .598 centares of ground, how many ounces, pennyweights, etc. does it weigh?

39. If a bed of anthracite coal cover $3\frac{1}{2}$ acres and extend to the depth of 2 meters, how many tons, hundred-weight etc., may be mined from it?

40. A passenger and a freight train leave the ter-

mini of a railway at the same time. When the freight is 772.464 hektometers from its starting-point, the passenger train running twenty-four miles per hour (or one and a half miles while the freight runs one) passes it. What is the length of the railway in miles?

41. A tank which holds 440 bushels of grain will hold how many Kl. Hl., etc., of water?

42. A miller wants to store up 24 million dekaliters of water. His pond covers 4 Ha. of land. To what depth in meters must he flood it to have the required amount of water?

43. If a lead pipe 2 Km. 2 Hm. 7 Dm. long, weighing 5 Kg. per meter, be melted and 8 double-dekaliter crucibles be filled, and from the remainder 192000 bullets weighing one ounce each be made, how many tons, cwt. etc., will remain?

44. Find in U. S. denominations the weight of one liter of mercury, of which a gill weighs 3.555 lbs. avoird.

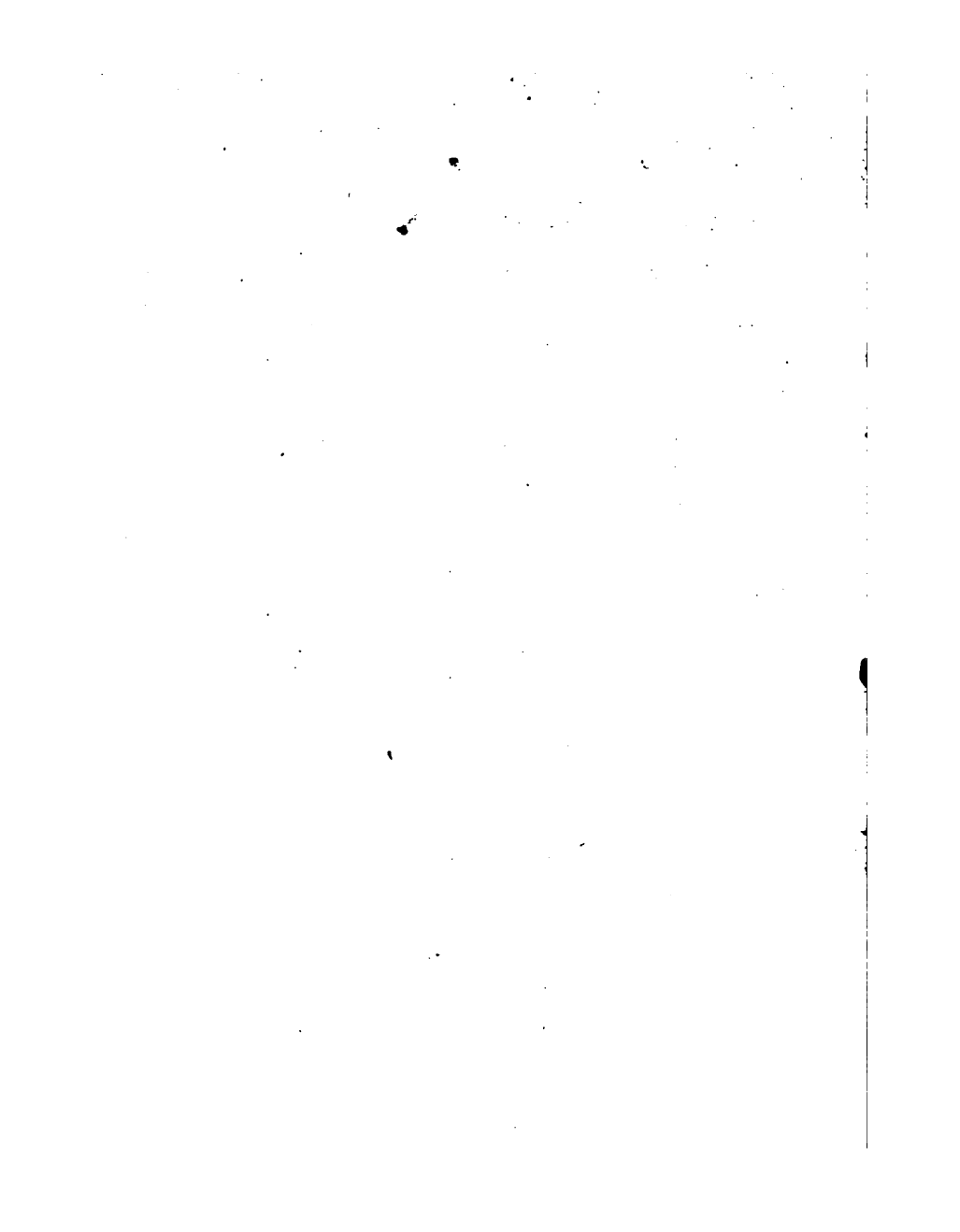
45. A grove of maple trees 1 kilometer long and 5 hektometers wide has on an average 5 trees to each 2 ares of ground. The owner estimates that each cord of growing maple yields 1.5 gallons of sap and that the trees contain 8 steres each. How many hektoliters of sap will the entire grove yield?

46. A merchant imports 20 double-hektoliter casks of wine. It cost him in France 520 francs per cask and the expenses to warehouse in N. Y. amounted to \$12 per cask. He sells it at \$3 per gallon; at 5 francs to the dollar what are his net profits?

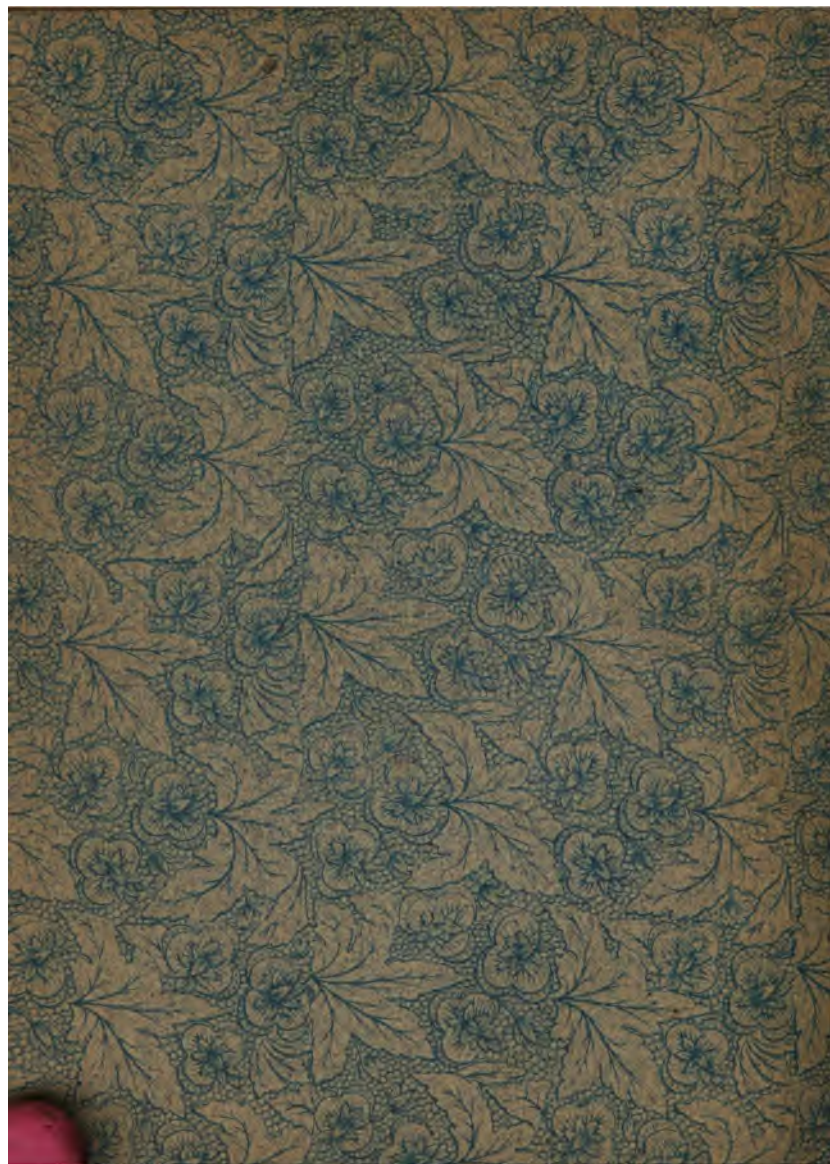
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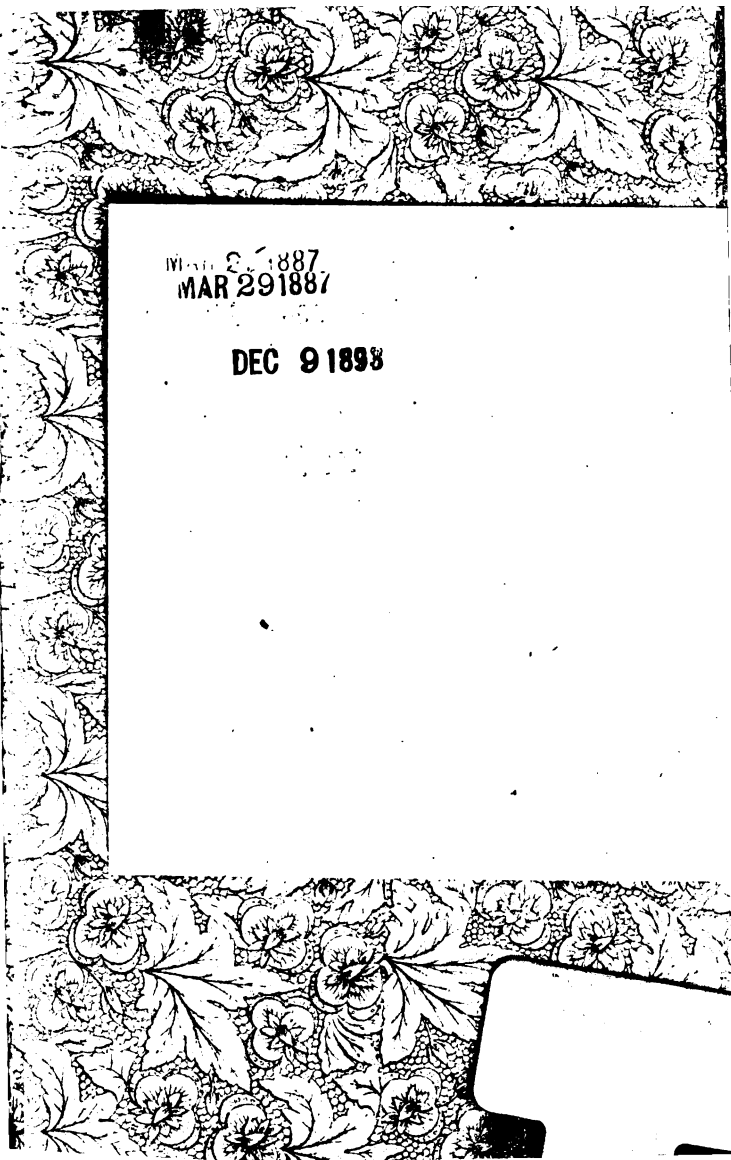
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